

No. 6.— *The Brachiopoda of the Maquoketa of Iowa.*

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INTRODUCTION.

THE publication of a large number of new and curious trilobites from the Maquoketa of Clermont and nearby localities in northeastern Iowa by Slocum has caused renewed attention to be given to a region which has for many years been known for its fossils. In 1917, in company with Prof. P. E. Raymond, I spent a week at Clermont, where, with the efficient guidance and assistance of Mr. A. H. Becker, a collection of representative fossils was secured. The present paper is primarily a description of the brachiopods, and though there are fewer novelties among the brachiopods than were found among the trilobites from the same locality, it is nevertheless true that, including the eight new species, nineteen out of twenty-seven species are known only from the Maquoketa. *Lingula beltrami*, *Plectorthis (Austinella) kankakensis*, *P. (A.) whitfieldi*, *Dalmanella macrior*, *D. corpulenta*, *Dinorthis proavita*, *Leptaena unicostata*, *Strophomena acuta*, *S. wisconsinensis*, *S. planodorsata*, and *Parastrophia divergens* are, with few exceptions, restricted to the highest Ordovician of Iowa, Minnesota, and Wisconsin, and none of them has been found in Ohio or Indiana. Five of the remaining eight species, *Hebertella insculpta*, *Plaesiomys subquadrata*, *Strophomena neglecta*, *S. nutans*, and *Rhynchotrema capax* are characteristic fossils of the typical Richmond, while three, *Crania laelia*, *Hebertella sinuata*, and *Plectambonites rugosus*, are found in both the Cincinnati and Richmond.

The Trentonian aspect of the fauna is expressed in some of the Strophomenae, in the small *Plectambonites* and *Zygospira*, and in the presence of *Parastrophia*. The dominant facies is, however, Richmondian, though none of the typical fossils of the late Richmond is present.

MAQUOKETA SHALE.

Position and Distribution:—Few formations have been more written about or more misunderstood than the Maquoketa shale. Hall, the first to recognize it, called it the "Hudson River formation," a term which is now bereft of meaning. It was first formally labeled "Maquoketa shale" in 1870 by White, who supposed it to represent

some particular epochal subdivision of the Cincinnati group. This non-committal usage of the term has continued to the present time, so that now as formerly, the Maquoketa comprises those late Ordovician sediments that occur in Iowa, Wisconsin, Minnesota, and Illinois, underlain by the massive Galena and overlain by the equally massive dolomite of the Niagara.

The exposures of this formation extend over a long narrow area in the states mentioned, usually bordering the Mississippi River. It follows the same northwest, southeast strike as the Galena and Niagara. The most southerly exposure is in Jackson County, Iowa. South from there, it disappears and the Galena and Niagara meet. To the north the Maquoketa thickens and attains a maximum of 200 ft. (Calvin). In northeastern Iowa it again decreases and slowly thins out in southern Minnesota, where in some places it is discernible with a thickness of but a few inches.

The great difficulty encountered in attempting to correlate the Maquoketa shale is due to the fact that the formation has not been correlated either lithologically or palaeontologically within itself. Equivalent strata of different but not very widely separated localities often show entirely dissimilar lithologic and faunal characters. For example, the heavy dolomitic beds at Clermont have no vestige of similarity to the strata of the typical region at Graf, Iowa. The *Ctenodonta* and *Orthoceras* beds of Dubuque County are not present in Fayette or Winneshiek Counties. In the light of this fact it can be appreciated why investigators have had difficulty in correlating these beds with any part of supposed equivalents in Ohio or New York.

Origin: — The heterogeneity of the Maquoketa shale has led writers to infer a shallow water or shore origin. The great localization of faunas and the local lithologic variation is the basis of this decision. In many places the muddy facies of shore deposition is evident. Shrinkage cracks on some of the layers, the broken condition of most of the fossils and a certain irregularity in bedding in Winneshiek County, Iowa, led members of the state Survey to call this an old beach deposit (1905). The Maquoketa appears to have been laid down in comparatively shallow water, just how deep it is impossible to say. The land-locked Galena sea with its arid shores and salty waters gave way to a body of water freely communicating with the open ocean. Mechanical sediments, indicative of general rainfall, were laid down in water of normal density. The lithologic and faunal differences were no greater than those to be seen in the sediments and life of shallow seas today.

A marked lithologic change is observed in all places at the boundary between the Galena and Maquoketa. Whether the Maquoketa was preceded by a period of erosion is still uncertain. In Dubuque County, Iowa, no erosion of the Galena can be noticed and no unconformity. At Graf, on the other hand, the Galena dolomite and the blue shale of the Maquoketa have a bed of yellow clay between them, a suggestion of erosional unconformity.

Lithologic Character:— Although much variation in composition is typical of the Maquoketa, dark bluish gray clay-shale predominates.

The formation may occur as a single undivided body of shale. In one locality it outcrops as dolomite and limestone to a thickness of forty feet. In northern Iowa the formation falls naturally into four members:—

4. Brainerd shale.

Blue and bluish gray shale with strata of limestone interbedded at top and bottom. 120 feet.

3. Fort Atkinson limestone.

Massive yellow cherty dolomite with associated beds of limestone. 40 feet.

2. Clermont shale.

Bluish, plastic, fine-grained shale, well developed at Clermont, Iowa. 15 feet.

1. Elgin shaly limestone.

Limestone, dolomite, shaly limestone with beds of calcareous shale and thin partings of bluish less calcareous clay that are variable in character and fossil content.

This division, unfortunately, does not persist throughout the formation. A division into three members seems to be the more universally applicable although this is not a hard and fast rule.

LINGULIDAE.

LINGULA BELTRAMI Winchell and Schuchert.

Lingula beltrami Winchell and Schuchert, Geol. Minn., 1893, 3, pt. 1, p. 351, fig. 25 a, b.

A single incomplete specimen representing parts of both valves was obtained from the Lower Maquoketa at Clermont. The condition of preservation is not such as to justify any special description.

CRANIIDAE

CRANIA LAELIA Hall.

Crania laelia Hall, Descrip. Crinoidea etc., 1866, p. 131. 24th Rept. N. Y. State cab. nat. hist., 1872, p. 220, pl. 7, fig. 16. Miller, Cinc. quart. journ. sci., 1875, 2, p. 12. Hall and Whitfield, Pal. Ohio, 1875, 2, p. 75, pl. 1, fig. 16. Hall and Clarke, Pal. N. Y., 1892, 8, pt. 1, pl. 41, fig. 1. Grabau and Shimer, N. A. index fossils, 1907, 1, p. 297, fig. 242. Cummings, 32d Ann. rept. Dept. geol. nat. res. Indiana, 1908, p. 897, p. 33, fig. 2.

Shell small, inequivalve, oval in outline, with width greater than length. Dorsal valve highly convex; beak elevated, pointed, situated nearly in the middle of the shell.

Surface marked by concentric lines of growth as well as radial striations. The latter vary considerably in number and strength.

This shell is quite common in the Maquoketa at Clermont, Iowa, and is usually found attached to an orthid or Rafinesquina. In no case was the *Crania* marked like the surface of the host.

Locality: — Maysville and Richmond; Cincinnati, Ohio, and many localities in Ohio, Indiana, Kentucky, Tennessee, etc., Lower Maquoketa at Clermont, Iowa.

ORTHIDAE.

The most recent faunal lists have not adequately suggested the variety of Orthidae to be found in the Maquoketa. Until quite recently *Plectorthis* (*Austinella*) *whitfieldi* (N. H. Winchell) was the only member of this common Palaeozoic family definitely identified from the various outcrops in Iowa, Illinois, Wisconsin, and Minnesota.

PLECTORTHIS (AUSTINELLA) KANKAKENSIS (McChesney).

Orthis kankakensis McChesney, New Pal. fossils, 1861, p. 77. Trans. Chicago acad. sci., 1868, 1, p. 29, pl. 9, fig. 3.

Plectorthis kankakensis Hall and Clarke, Pal. N. Y., 1892, 8, pt. 1, p. 221, pl. 5, fig. 24, 25.

Austinella kankakensis Foerste, Bull. sci. lab. Denison univ., 1909, 14, p. 224.

The difference between *P. kankakensis* and *P. whitfieldi* is mentioned in the discussion of the latter species. Both occur plentifully at

Clermont and are the most numerous of the Orthidae in the Maquoketa of that locality. *P. kankakensis* is the wider and has more striations. Below is a comparison of average specimens of each.

	Length	Width	Greatest convexity	Number striations
<i>A. kankakensis</i>	26 mm.	30 mm.	13 mm.	60
<i>A. whitfieldi</i>	26.5 mm.	27 mm.	13 mm.	46.

Locality:—The Fernvale at Wilmington, Illinois and the Lower Maquoketa at Clermont, Iowa. M. C. Z. 8,536.

PLECTORTHIS (AUSTINELLA) WHITFIELDI (N. H. Winchell).

Plate 1, fig. 1.

Orthis whitfieldi N. H. Winchell, 9th Ann. rept. geol. nat. hist. surv. Minnesota, 1881, p. 115.

Orthis pectinella Whitfield (part), Geol. Wisc., 1882, 4, p. 259, pl. 12, fig. 8.

Plectorthis whitfieldi Hall and Clarke, Pal. N. Y., 1892, 8, pl. 1, p. 221, pl. 5, fig. 26.

Orthis (Plectorthis) whitfieldi Winchell and Schuchert, Geol. Minn., 1893, 3, pt. 1, p. 437, pl. 33, fig. 8-13.

Austinella whitfieldi Foerste, Bull. sci. lab. Denison univ., 1909, 14, p. 244 (gen. ref.); 1912, 17, p. 131, pl. 8, fig. 9.

?*Plectorthis* sp. cf. *whitfieldi* Ruedemann, Bull. 162, N. Y. state mus., 1912, pl. 4, fig. 8.

This species is closely related to *Plectorthis (Austinella) kankakensis* (McChesney) of the Fernvale at Wilmington, Illinois, but is always less extended along the cardinal area and more square in outline. It is hard to separate these species in some instances, because of the variation in the number of striations which characterizes them both. Where they occur abundantly together, as at Clermont, they have a tendency to intergrade into each other.

The pedicle-valve has a distinct beak; cardinal area arched; delthyrium triangular. The striations are quite strong; their number varies from thirty-six to forty-eight. This is the chief distinction between *whitfieldi* and *kankakensis*, the latter possessing sixty to seventy striae on the anterior margin. The striations in both species increase by implantation.

The brachial-valve is much less convex than the other; a slight flattening along the middle grades into a slight concavity at the

anterior margin in large specimens. In some cases the exterior of this valve is marked by fine concentric striations.

A typical specimen measured: —

Width 27 mm., Length 26.5 mm., Greatest convexity 13 mm.

Locality: — Richmond at Spring Valley and Granger, Minnesota; Delafield, Wisconsin; Savannah, Illinois; Clermont, and Lattners, Iowa. M. C. Z. 8,535.

HEBERTELLA SINUATA (Hall).

Orthis sinuata Hall, Pal. N. Y., 1847, **1**, p. 128, pl. 32B, fig. 2. Miller, Cinc. quart. journ. sci. 1875, **2**, p. 36.

Orthis occidentalis var. *sinuata* Meek, Pal. Ohio, 1873, **1**, pt. 2, p. 98.

Hebertella sinuata Hall and Clarke, Pal. N. Y., 1892, **8**, pt. 1, p. 222, pl. 5A, fig. 1-8. Hayes and Ulrich, Folio 95 U. S. G. S. illus. sheet, 1903, fig. 17. Cumings, Amer. journ. sci., 1903, ser. 4, **15**, p. 34, footnote. Foerste, Bull. sci. lab. Denison univ., 1910, **16**, p. 52, pl. 2, fig. 5.

Hebertella occidentalis sinuata Schuchert, Bull. 87, U. S. G. S., 1897, p. 229. Cumings, 32nd Ann. rept. Dept. geol. nat. res. Indiana, 1908, p. 908, pl. 34, fig. 3-3e.

Hebertella sinuata differs from *H. occidentalis* in the absence of the slight median depression near the beak of the pedicle-valve of the latter. This species is very common throughout the Richmond, and everywhere shows great similarity to *H. occidentalis*. The primary striations are coarser than those of the latter, but all intermediate stages can usually be found.

Since all the specimens from the Upper Maquoketa at Brainerd, Iowa, were coarsely striated, no differentiation of two forms was indicated.

Length	Width	Convexity
30 mm.	40 mm.	25 mm.
32 mm.	36 mm.	21 mm.
16 mm.	29 mm.	15 mm.

Locality: — Maysville and Richmond; southern Ohio; Kentucky; Tennessee; Indiana; Iowa, etc.

HEBERTELLA CLERMONTENSIS, sp. nov.

Plate 1, fig. 3.

Shell small, length about four fifths of the width, with slight individual variation. Hinge-line a trifle less than the middle width of

the shell; cardinal angles tend to squareness so as to produce an approximately rectangular outline.

The pedicle-valve has a medial ridge, gently convex at the anterior edge, but growing sharper toward the posterior margin where it merges into a pointed beak, that deviates but slightly from the vertical.

The brachial-valve is about equally convex with the pedicle and possesses a shallow sinus which begins at the anterior margin and continues nearly to the beak, where it merges into the general convexity of the shell.

Striations are well defined, almost coarse; thirty-eight to forty-four occur along the anterior margin. The lateral striae increase by bifurcation; the medial ones are always simple.

A typical specimen measured:—

Length	Width	Convexity	Striations of pedicle-valve
13 mm.	15 mm.	6 mm.	40

Locality:— Lower Maquoketa in the vicinity of Clermont, Iowa. Holotype, M. C. Z. 8,537.

HEBERTELLA (GLYPTORTHIS) INSCULPTA (Hall).

Orthis insculpta Hall, Pal. N. Y., 1847, **1**, p. 125, pl. 32, fig. 12. Billings, Geol. Canada, 1863, p. 167, fig. 150. Meek, Pal. Ohio, 1873, **1**, p. 99, pl. 9, fig. 1. Miller, Cine. quart. journ. sci., 1875, **2**, p. 40. Emmons, Amer. geology, 1855, **1**, pt. 2, p. 195, pl. 9, fig. 12. Shaler, Mem. Geol. surv. Kentucky, 1876, **1**, p. 30.

Orthis (Hebertella) insculpta Winchell and Schuchert, Geol. Minn., 1893, **3**, pt. 1, p. 435.

Hebertella insculpta Hall and Clarke, Pal. N. Y., 1892, **8**, pt. 1, p. 222, pl. 5A, fig. 13. Cumings, 32nd Ann. rept. Dept. geol. nat. res. Indiana, 1908, p. 905, pl. 34, fig. 2-2d.

Glyptorthis insculpta Foerste, Bull. Sci. lab. Denison univ., 1914, **17**, p. 258 (gen. ref.).

Orthis bellarugosa Hall (not Conrad), 2d. Ann. rept. N. Y. state geol., 1883, pl. 35, fig. 22.

Three specimens from Clermont had the following dimensions:—

Length	Width	Greatest convexity
15 mm.	18 mm.	7 mm.
9 mm.	11 mm.	5 mm.
10 mm.	13 mm.	6 mm.

Locality:— Oxford, etc., Ohio; Indiana; Wilmington, Illinois; Wisconsin; Iowa; Minnesota; Tennessee.

DALMANELLA MACRIOR (Sardeson).

Orthis macrior Sardeson, Bull. Minn. acad. sci., 1892, **3**, p. 330, pl. 5, fig. 5-7.

Orthis (Dalmanella) testudinaria var. *emacerata* Winchell and Schuchert, Geol. Minn., 1893, **3**, pt. 1, p. 445, pl. 33, fig. 23-24.

Orthis emacerata Sardeson, Amer. geol., 1897, **19**, p. 102, pl. 5, fig. 14-18, 28.

Shells subquadrangular, broadest at or near the hinge, nearly as long as wide.

Pedicle-valve convex; brachial nearly flat; concentric lines sometimes present. A single median plication is prominent near the pedicle-beak. The median fold grows wider and higher toward the anterior margin and is bounded by depressed areas.

The brachial-valve has a corresponding depression, and the striations resemble those of *D. rogata* Sardeson. There is a total lack of all minuter surface markings.

Typical specimens measured: —

Length	Width	Greatest convexity
11 mm.	12.5 mm.	4.5 mm.
11 mm.	13 mm.	5 mm.
9 mm.	10.5 mm.	4.5 mm.
13 mm.	15 mm.	5 mm.
6 mm.	7.5 mm.	3 mm.

The common *Dalmanella* found in the Maquoketa at Clermont has usually been called *D. emacerata*, but differs from it in having a deeper sinus and more pronounced fold, and in having the lateral margins more nearly parallel. Sardeson's name for the species may therefore be revived although he himself did not use it in his second paper.

Locality: — Maquoketa in Minnesota; Lower Maquoketa at Clermont, Iowa.

DALMANELLA CORPULENTA (Sardeson).

Orthis corpulenta Sardeson, Bull. Minn. acad. nat. sci., 1892, **3**, p. 330, pl. 5, fig. 8-10. Amer. geol., 1897, **19**, p. 107, pl. 4, fig. 11-19.

Orthis (Dalmanella) testudinaria var. *meekei* Winchell and Schuchert (non Miller), Geol. Minn., 1893, **3**, pt. 1, p. 445, pl. 23, fig. 25-29.

A few specimens appear to belong to this species, which is common in the Maquoketa of Minnesota but unknown elsewhere. The hinge is short, the form subcircular in neanic but rather elongate in adult specimens, the median fold is not strongly delineated, and the sinus

is shallow. The convexity is not such as to suggest their trivial name, but it appears from Sardeson's description that this was an allusion to the condition of gerontic specimens.

Measurements: — The largest specimen is 12.75 mm. long, 13 mm. in greatest width, and 9 mm. wide at the hinge. A smaller one is 8.75 mm. long, 9.25 mm. wide, and 7 mm. wide at the hinge.

Locality: — A rare species in the Lower Maquoketa at Clermont, Iowa, previously reported only from the same formation at Granger and Spring Valley, Minn.

PLAESIOMYS SUBQUADRATA Hall.

Orthis subquadrata Hall, Pal. N. Y., 1847, **1**, p. 121, pl. 32A, fig. 1. Geol. Wisc. 1862, **1**, p. 54, fig. 1, 2. Meek, Pal. Ohio, 1873, **1**, p. 94, pl. 9, fig. 2. Miller, Cincinnati quart. journ. sci., 1875, **2**, p. 38. White, 2d. Ann. rept. Indiana bur. state geol., 1880, p. 484, pl. 1, fig. 3-5. Shaler, Mem. Geol. surv. Kentucky, 1876, **1**, p. 22, pl. 7. Keyes, Missouri geol. surv., 1895, **5**, p. 60.

?*Orthis subquadrata* Billings, Geol. Canada, 1863, p. 165, fig. 146.

Platystrophia subquadrata Hall, 36th Rept. N. Y. state mus. nat. hist., 1884, p. 75, pl. 3, fig. 4.

Plaesiomys subquadrata Hall and Clarke, Pal. N. Y., 1892, **8**, pt. 1, p. 194, 196, 222, pl. 5A, fig. 17-19.

Orthis (Dinorthis) subquadrata Winchell and Schuchert, Geol. Minn., 1893, **3**, pt. 1, p. 428, pl. 32, fig. 46-50. Whiteaves, Pal. foss. Canada, 1897, **3**, pt. 3, p. 176.

Dinorthis subquadrata Hayes and Ulrich, Folio 95 U. S. G. S. illus. sheet, 1903, fig. 7, 8. Cumings, 32nd Ann. rept. Dept. geol. nat. res. Indiana, 1908, p. 904, pl. 34, fig. 1-1b.

Two specimens of this common species were found at Clermont by the writer. This fossil is very characteristic of the Upper portion of the Maquoketa shale and is found plentifully at Spring Valley, Minnesota. These rocks are known to be of about the same age as the Maquoketa of Iowa, so one must look for the cause of the scarcity of *Dinorthis subquadrata* in the shales at Clermont.

This species is more convex than the Orthidae with which it is associated. It has a shallow sinus on the pedicle-valve, but not nearly so pronounced a one as that of its close relative, *Dinorthis proavita*. One feature separates it conclusively from the other species in this locality; the posterior lateral radiating striae curve so strongly outward that a few of them run out on the cardinal edge before reach-

ing the lateral margins. Striae increase by bifurcation on the pedicle-valve and by intercalation on the brachial.

Winchell and Schuchert have pointed out how *Dinorthis meedsi* developed from *D. pectinella* var. *sweeneyi* by the multiplication of striae; how this development was carried further in *D. meedsi* var. *germana*, and how this form is closely linked with *Plaesiomys subquadrata*. *Dinorthis proavita* and *Plaesiomys subquadrata* show a reversion to ancestral characteristics in the simplicity of the striae and the rareness with which interpolation and bifurcation takes place beyond the early neanic stage.

Length	Width	Greatest convexity
26 mm.	30 mm.	16 mm.

Locality: — Richmond, Ind.; Spring Valley, Minnesota; Wilmington, Illinois; Warren and Jefferson counties, Missouri; Lattners, Clermont, Iowa; Iron Ridge, Wisconsin; Lake Winnipeg, Canada; Anticosti; Texas.

DINORTHIS PROAVITA Winchell and Schuchert.

Plate 1, fig. 4.

Orthis proavita Winchell and Schuchert, Amer. geol., 1 April, 1892, **9**, p. 290.

Orthis petrae Sardeson, Bull. Minn. acad. nat. sci., 9 April, 1892, **3**, p. 332, pl. 5, fig. 18-21.

Orthis (Dinorthis) proavita Winchell and Schuchert, Geol. Minn., 1893, **3**, pt. 1, p. 431, pl. 32, fig. 51-57. Whiteaves, Pal. foss. Canada, 1895, **3**, pt. 2, p. 120; 1897, **3**, pt. 3, p. 176.

Dinorthis proavita Schuchert, Bull. 87, U. S. G. S., 1897, p. 216.

Several specimens of this species were found at Clermont and resemble in all essentials the types from Spring Valley, Minnesota. The striae increase by interpolation on the brachial and by bifurcation on the pedicle-valve. The latter is somewhat elevated at the umbo, flattened and in some cases concave toward the lateral and anterior margins with a slight mesial elevation. The distinguishing characteristic of this form is the brachial-valve which is always convex and possesses a well-pronounced sinus. No other species of Orthidae present at Clermont has the very noticeable sinus of this species.

Dinorthis proavita and *D. iphigenia* Billings are superficially similar, but they have the fold and sinus reversed. The latter has a greater number of striae and is found only in the Trenton of Canada.

Dinorthis proavita at Clermont, probably the most common species, is smaller than most of the other Orthidae.

Length	Width	Greatest convexity
8.5 mm.	10 mm.	2.5 mm.
11.5 mm.	16 mm.	5 mm.
17.5 mm.	21 mm.	8 mm.

Locality:—Common in the upper portion of the Maquoketa at Spring Valley, Minnesota and Wilmington, Illinois; Lower Maquoketa at Clermont, Iowa. M. C. Z. 8,538.

STROPHOMENIDAE.

PLECTAMBONITES RUGOSUS (Meek).

Leptaena rugosa James, Cat. fossils Cincinnati group, 1871.

Leptaena sericea var. *rugosa* Meek, Pal. Ohio, 1873, 1, pt. 2, pl. 5, fig. 3f, g, h.

Plectambonites rugosa Foerste, Bull. sci. lab. Denison univ., 1912, 17, p. 123, pl. 1, fig. 7a-e; pl. 10, fig. 7a-d.

Leptaena aspera James, Cine. quart. journ. sci., 1874, 1, p. 151.

?*Plectambonites sericeus* var. Ruedemann, Bull. 49, N. Y. state mus., 1901, p. 18, pl. 1, fig. 6, 7; *ibid.*, 8, p. 525.

The typical specimens of this species were found in the Eden at Cincinnati, Ohio. The name *rugosa* was applied because of the roughened exterior surface and the oblique wrinkles along the hinge-line.

The concentric banding and filming is often absent as well as the consequent thickening of the valves anteriorly. This is the case with most of the specimens from the Maquoketa near Clermont, Iowa; the surface is comparatively smooth except for concentric striae present on some forms.

Plectambonites rugosus has a considerable vertical range; it is most abundant in the Eden, but similar forms have been found in the Waynesville and Liberty members of the Richmond. Much variation of outline occurs within the species, and on the same slab examples may be seen representing all stages between the semielliptical and the elongate quadrangular. These shells grow more in width than length, and environment often differentiates them so greatly as to

raise the question whether all the specimens under discussion should be considered one species.

Length	Width	Convexity
8 mm.	14.5 mm.	2 mm.
7 mm.	12 mm.	2.5 mm.
8 mm.	12 mm.	2 mm.

Locality: — Eden, Cincinnati, Ohio; Richmond (Maquoketa) at Clermont, Iowa.

LEPTAENA UNICOSTATA (Meek and Worthen).

Plate 2, fig. 5.

Leptaena (n. sp.?) Owen, Geol. surv. Wisconsin, Iowa, Minnesota, 1852, pl. 2B, fig. 3.

Strophomena unicastata Meek and Worthen, Geol. surv. Illinois, 1868, 3, p. 335, pl. 4, fig. 11. Whitfield, Geol. Wisc., 1882, 4, p. 262, pl. 12, fig. 14.

Rafinesquina unicastata Hall and Clarke, Pal. N. Y., 1892, 8, pt. 1, pl. 15A, fig. 39, pl. 20, fig. 25.

Leptaena unicastata Winchell and Schuchert, Geol. Minn., 1893, 3, pt. 1, p. 411, pl. 32, fig. 6-9. Whiteaves, Pal. foss. Canada, 1897, 3, pt. 3, p. 174.

This form occurs plentifully on thin slabs of limestone at the very top of the Ordovician in the Maquoketa at Patterson's Spring, near Brainerd, Iowa. The specimens lack any sign of the wrinkling present in some of the examples from Spring Valley, Minnesota. This species can be distinguished from the American form now called *Leptaena tenuistriata* Sowerby by the obsolete wrinkling, the large mid-rib and the large bilobed diductor scars of the pedicle-valve. *Strophomena nitens* Billings, an Anticostian form, closely resembles *L. unicastata* exteriorly but not interiorly.

Length	Width	Convexity
14 mm.	21 mm.	3 mm.
12 mm.	20 mm.	5 mm.

Locality: — Richmond; Savannah, and Wilmington, Illinois; Delafield, Wisc.; Spring Valley and Granger, Minn.; Lattners, Brainerd, Iowa; Rapids of Nelson River, Lake Winnipeg, Manitoba; Texas, etc. M. C. Z. 8,546.

LEPTAENA RAYMONDI, sp. nov.

Plate 2, fig. 3, 4.

Shell small; hinge width 15 to 17 mm., which is the greatest width of the shell. Length, 9 to 10 mm. Pedicle-valve convex and strongly deflected near the anterior margin. The concave brachial-valve follows closely the convexity of the other. Cardinal area on the pedicle-shell narrow, never exceeding 2 mm. in width, with a small triangular deltidium. No interior known.

The surface of some specimens is marked by fine radiating striae which grow heavier on the deflected area of the pedicle-valve. In most cases these striations are not noticeable and never attain the prominence of those on *L. unicostata*, which is common in the Upper Maquoketa. A strong mesial line is present on the pedicle-valve and often bifurcates before it reaches the anterior margin, in some specimens very near the hinge line.

Locality: — Lower Maquoketa at Clermont, Iowa. Holotype, M. C. Z. 8,545.

Several species of *Rafinesquina* and *Strophomena* occur plentifully in the Upper Maquoketa at localities north and west of Clermont, Iowa. *R. kingi* (Whitfield), *S. cardinalis* (Whitfield), and *S. fluctuosa occidentalis* Foerste, common in the Maquoketa of other Upper Mississippi Valley localities, were not found by the writer.

A general characteristic of the new species of *Rafinesquina* and *Strophomena* described below is that they are considerably smaller than species from other localities in the Richmond. This dwarfing may have been the first manifestation of the force which drove both genera to extinction at the close of the Ordovician.

Although dwarf faunas were common in Palaeozoic times, as they are now, it is not always easy to determine the cause. In the case of the one under discussion, there were probably many contributory causes. It appears that any change from the usual environmental conditions affect the sensitive soft parts of marine invertebrates. Professor Shimer says on this point, "Whatever ill or good conditions the animal is subjected to are expressed in the shell, as moist and dry summers are recorded by the annual rings of exogenous trees."

With the universal uplift that came as the grand finale to the Ordovician period, many changes were wrought that had great influence upon life in the sea. With the receding of the waters, lakes, and shallow bays were formed that lost their connection with the

main sea. The life entrapped in these basins must have been subjected to new environmental conditions. A change in the chemical constitution resulting from a freshening of the sea-water due to the new drainage; a concentration of salt; an abnormal increase in hydrogen sulphide and other gases; mud and other impurities; variations in the temperature and the depth of water are agencies in dwarfing according to Professor Shimer.

It seems that in the case of the *Strophomenae* and *Rafinesquinae* from Clermont, the ingress of mud was probably the determining factor. Upon examination of the fine-grained shales that contain these fossils, it is easy to imagine that conditions during the Maquoketa deposition in this region were not unlike those that exist today in the Mediterranean Sea. De Lapparent noticed that while the fauna of the western Mediterranean was dwarfed, that of the eastern part was still further affected. He attributed this to the presence in the water of the eastern basin of fine particles of mud, which sank to the bottom only very slowly. Fine grains of mud taken into the tender soft parts of these brachiopods might easily have caused an irritation that would result in the prevention of normal growth.

RAFINESQUINA ALTIDORSATA, sp. nov.

Plate 2, fig. 2.

Shell small and highly convex, almost hemispherical, with the greatest convexity in mature specimens a little nearer the beak than the anterior margin, although very nearly mid-way between.

The more prominent radiating lines of the pedicle-valve occur at intervals of less than one millimeter and the intermediate spaces are occupied by four to six finer striae.

The interior of the brachial-valve is thickened along the anterior margin. Three ridges running lengthwise to the hinge embrace the four adductor muscle-scars.

Typical specimens measured: —

Width	Length	Greatest convexity
22 mm.	19 mm.	11 mm.
24.5 mm.	19 mm.	10 mm.
26 mm.	19.5 mm.	13.5 mm.

The common Maquoketa representative of the genus at Delafield, Wisconsin and Spring Valley, Minnesota, is *R. kingi* (Whitfield), but its place was taken at Clermont by two new forms, *R. subquadrata* and

R. altidorsata. They are much smaller than *R. kingi* and show the tendency to dwarfing that characterizes this fauna. *R. subquadrata* and *R. altidorsata* differ greatly from *R. kingi* and seem to be the first dwarf forms described from the Maquoketa.

Locality:—Lower Maquoketa at Clermont, Iowa. Holotype, M. C. Z., 8,544.

RAFINESQUINA SUBQUADRATA, sp. nov.

Plate 2, fig. 1.

Shell of medium size, with a tendency to squareness; width at hinge-line usually maintained and occasionally slightly exceeded as far as two thirds the distance to the anterior margin. Cardinal angles regularly square, but in some specimens slightly alate.

Striations of the pedicle-valve alternate; usually three, sometimes two or four finer striae embraced by two coarser ones in the region directly anterior to the beak. All regularly grow heavier as the shell grows older and increase by implantation, so that four or five finer striae are embraced by two coarser. The greatest convexity of the pedicle-valve is between one half and two thirds the distance from beak to anterior margin; at this point there is a rather sharp inflection of the shell.

The striations on the brachial correspond to those of the pedicle-valve, but are not so pronounced. The concavity of this shell follows closely the convexity of the other like two nested cups.

The cardinal area is narrow, scarcely two millimeters wide at the most. Pedicle-opening very minute, just visible to the eye.

Three typical specimens measured:—

Width	Length	Greatest convexity
27 mm.	26.5 mm.	10 mm.
27 mm.	26.5 mm.	11 mm.
27 mm.	30 mm.	12 mm.

Locality:—Lower Maquoketa at Clermont, Iowa. Holotype, M. C. Z. 8,543.

RAFINESQUINA RUGULIFERA, sp. nov.

Rafinesquina alternata var. *loxorhytis* Winchell and Schuchert (not Meek), Geol. Minn., 1893, 3, pt. 1, p. 407, pl. 31, fig. 35-37; pl. 32, fig. 59, 60.

Shell much broader than long, widest at the hinge, which projects into broad "ears" which are demarked by shallow depressions. Pedicle-valve gently and rather evenly convex, highest in front of

the middle. The brachial shell, except in the umbonal region, follows the curvature of its opposite. The striae of the umbonal region are of uniform size, but towards the front they show distinct alternations, and there are from one to three fine striations between each pair of coarse ones, the number varying with the distance from the margin. When the shell is partially exfoliated, rows of conspicuous pores are disclosed in the furrows between the striae. Some specimens show distinct wrinkles on the sides near the hinge. Some are located nearly at right angles with the hinge, others diagonally, the variable position suggesting pathologic origin for these features.

Measurements:— A specimen from the Lower Maquoketa near Clermont is 41 mm. long, and about 65 mm. wide; one figured by Winchell and Schuchert is 40 mm. long and 60 mm. wide.

Rafinesquina alternata var. *loxorhytis* was a name suggested by Meek (Pal. Ohio, 1873, 1, p. 91) in a brief description which was not accompanied by a figure. The variety does not appear to have been identified successfully away from Cincinnati, and, as Cumings has remarked, (32d Ann. rept. Dept. geol. nat. res. Indiana, 1908, p. 928) the characteristic which appeared most important to the describer may not be a reliable one. Meek relied upon the extended form and obliquely wrinkled lateral extremities for the identification of this variety, but oblique wrinkles near the cardinal margin have proven in many cases to be the accompaniment of individual senescence or result of accident. The specimens from the Richmond of Indiana identified as *R. alternata loxorhytis* by Cumings lacked the wrinkles.

Winchell and Schuchert found a large *Rafinesquina* at Spring Valley, Minnesota, which they illustrated under this name, but which has recently been referred to *R. kingi* Whitfield (Bassler, Bull. 92, pt. 2, U. S. N. M., 1915, p. 1087.) If Whitfield's description and illustrations are correct, then the Minnesotan form cannot be *R. kingi*, for its author stated that that species showed no alternations of striae, and the figure shows the Wisconsin shell to be much longer than that from Minnesota.

Comparison with *R. alternata loxorhytis* cannot be satisfactory in our present ignorance of that variety, but Meek described it as having acutely angular, flattened, scarcely deflected cardinal angles, while the present species has convex "ears" which are set off by a conspicuous depression. It also has a much broader form than any of the shells which are usually designated as varieties of *R. alternata*.

Locality:— In the Maquoketa near Spring Valley, Minnesota, and Clermont, Iowa; rare at the latter place.

STROPHOMENA NEGLECTA (James).

- Strophomena filitexta* Meek (not Hall), Pal. Ohio, 1873, **1**, pt. 2, p. 83, pl. 6, fig. 5.
- ?*Strophomena filitexta* White, U. S. G. & G. S. W. 100th mer., 1875, **4**, p. 69, pl. 4, fig. 8.
- Hemipronites filitextus* Miller, Cinc. quart. journ. sci., 1875, **2**, p. 43.
- Streptorhynchus filitextus* (part) Hall, 2d. Ann. rept. N. Y. state geol., 1883, pl. 42, fig. 10, 15 (not fig. 11-14); pl. 39, fig. 1-7.
- Strophomena filitexta* Hall and Clarke, Pal. N. Y., 1892, **8**, pt. 1, pl. 9A, fig. 10, 15 (not fig. 11-14); pl. 11A, fig. 3.
- Streptorhynchus neglecta* James, Paleontologist, 1881, **5**, p. 41.
- Strophomena neglecta* Winchell and Schuchert, Geol. Minn., 1893, **3**, pt. 1, p. 388. Foerste, Amer. geol., 1903, **31**, p. 338. Cumings, 32d Ann. rept. Dept. geol. nat. res. Indiana, 1908, p. 934, pl. 38, fig. 1-1b. Foerste, Bull. sci. lab. Denison univ., 1912, **17**, pl. 5, fig. 1, 3; pl. 7, fig. 5; pl. 9, fig. 1; pl. 11, fig. 10.

All representatives of this species were found in a ravine north of Clermont, Iowa, and none in the neighboring outcrops. They conform well to the types figured and described by Foerste, although the average size is somewhat smaller. They all lack the vertical wrinkling along the hinge-line of *Strophomena vetusta*. The cardinal angles in all cases are acute, and no specimen shows the rectangular boxing of the postero-lateral angles.

Measurements:—Smallest specimen—width, 40 mm., length, 25.5 mm. Largest specimen—width, 56 mm., length, 35.5 mm. Average specimen—width, 44 mm., length, 27 mm.

Locality:—The Richmond at Oxford, Clarksville, Waynesville, Ohio; Indiana; and the Maquoketa at Savannah, Illinois; on Manitoulin Island, Lake Huron; Anticosti; and Stony Mountain, Manitoba.

STROPHOMENA ACUTA Winchell and Schuchert.

Plate 1, fig. 5.

- Strophomena neglecta* var. *acuta* Winchell and Schuchert, Geol. Minn., 1893, **3**, pt. 1, p. 388, pl. 31, fig. 6, 7.
- Strophomena acuta* Foerste, Bull. sci. lab. Denison univ., 1912, **17**, p. 115, pl. 7, fig. 3a-d; pl. 9, fig. 13a, b.

Three good specimens from Clermont, Iowa, show a general similarity to the figured types from the Maquoketa at Spring Valley,

Minnesota. All are shorter than those in Professor Schuchert's collection, and the anterior margins are less pointed. Very slight wrinkling is discernible on the valves near the hinge-line, and in one specimen is almost obsolete.

The striae are more distinct on the brachial- than on the pedicle-valve; clearly alternating, usually three or four, rarely two or five, finer between two coarser ones. The finer striae vary in intensity and in places are undulatory; the coarser in all cases are less erratic than the finer. Seven or eight of the prominent ones are counted in 5 mm. at the anterior margin.

One specimen has dimensions as follows: — Width along hinge-line, 28.5 mm.; across middle, 24 mm.; length of pedicle-valve, 20.5 mm.; of the brachial, 20 mm.; greatest convexity, 8 mm. at 13.5 mm. from the beak; height of cardinal area, 3.5 mm. This represents the medium of the three specimens. The largest had a width at the hinge of 37.8 mm. and length of pedicle-valve of 23 mm. The smallest had width at hinge 21.2 mm., and length of pedicle-valve 16.2 mm. A specimen from the type-locality measured by Foerste corresponded nearly to the first cited above, the main difference being a length of pedicle-valve greater by 1.2 mm. in the type.

Locality: — Richmond (Maquoketa); Spring Valley, Minnesota, and Clermont, Iowa. M. C. Z. S,539.

STROPHOMENA NUTANS Meek.

Strophomena (Hemipronites) nutans Meek, Pal. Ohio, 1873, **1**, pt. 2, p. 77, pl. 6, fig. 1.

Hemipronites nutans Miller, Cinc. quart. journ. sci., 1875, **2**, p. 46.

Streptorhynchus nutans Miller, N. A. geol. pal., 1889, p. 378.

Strophomena nutans Hall and Clarke, Pal. N. Y., 1892, **8**, pt. 1, p. 251, pl. 8, fig. 11; pl. 9A, fig. 5-7; pl. 11A, fig. 6, 7. Foerste, Amer. geol., 1903, **31**, p. 338. Cumings, 32d Ann. rept. Dept. geol. nat. res. Indiana, 1908, p. 936, pl. 38, fig. 5-5e. Foerste, Bull. sci. lab. Denison univ., 1912, **17**, p. 68, pl. 3, fig. 2a-c; pl. 9, fig. 15; pl. 10, fig. 2a-c; pl. 3, fig. 2 b; pl. 11, fig. 8; pl. 10, fig. 3a-d; pl. 9, fig. 16.

Several specimens of *Strophomena nutans* were found in the Lower Maquoketa four miles west of Clermont. They were all smaller than *S. concordensis* described by Foerste; but it is possible that he would call these forms depauperate gerontic examples of that species. The largest has a width of 28 mm., a length of 23.5 mm., and a greatest convexity of 10.5 mm. The average specimen measures 21 mm. in

width; 18 mm. in length; and 7 mm. in convexity. These dimensions alone would suggest that this form belongs to the more common *Strophomena nutans* and not the larger variety, *S. concordensis*, specimens of which frequently attain a width of 42 mm., a length of 30 mm., and a convexity of 11 to 15 mm.

Locality:—This is a common Richmond fossil occurring in the Blanchester division of the Waynesville bed in Butler, Warren, and Clinton Counties, Ohio; also in the environs of Richmond, Indiana.

STROPHOMENA WISCONSINENSIS Whitfield.

Plate 1, fig. 7, 8.

Strophomena wisconsinensis Whitfield, Geol. Wise., 1882, 4, p. 263, pl. 12, fig. 11-13. Hall and Clarke, Pal. N. Y., 1892, 8, pt. 1, p. 251, pl. 11A, fig. 1, 2. Foerste, Bull. sci. lab. Denison univ., 1912, 17, p. 108, pl. 7, fig. 1a-e; pl. 9, fig. 5a-e.

Evidently similar to specimens from the type-locality at Delafield, Wisconsin are the two from Clermont, Iowa. They are characterized by the great convexity of the brachial-valve which has a sudden flattening toward the posterior part, and the regular generic depression near the beak. The cardinal area of the pedicle-valve is almost parallel to the flattened surface.

One specimen is distinctive not only for its peculiar specific idiosyncrasies, but also for a pathologic condition shown in the arrestment of growth across the middle of the brachial-valve.

Length, 17 mm., width, 24 mm., greatest convexity, 9.5 mm.

The main difference between the specimens from Clermont and the types is that the cardinal area is not nearly so high in the former as in the latter.

Locality:—Delafield, Wisc., and Clermont, Iowa. M. C. Z. 8,541.

STROPHOMENA PLANODORSATA Winchell and Schuchert.

Strophomena planodorsata Winchell and Schuchert, Amer. geol. 1892, 9, p. 286. Geol. Minn., 1893, 3, pt. 1, p. 393, pl. 31, fig. 8-10. Foerste, Bull. sci. lab. Denison univ., 1912, 17, p. 109, pl. 7, fig. 4a, b, 7a, b, 8; pl. 9, fig. 6a, b, 7, 8a, b, 9, 11, 12, 14a, b.

At Patterson's Spring near Brainerd, Iowa, the Niagara limestone is well exposed. Below it lies a zone of shale six feet thick. Both

are quite barren of fossils. Next in descent is a highly fossiliferous calcareous shale, from which slabs were dug that literally teemed with fossil shells. Several of these slabs were obtained, and although *Rafinesquina* is well represented on them, *Strophomena* is absent with the single exception of a pedicle-valve of *Strophomena planodorsata*.

STROPHOMENA ABSCISSA, sp. nov.

Plate 1, fig. 6.

Shell small, roughly triangular in outline. Hinge-line straight; cardinal angles often mucronate, especially in the younger specimens. Greatest height of the cardinal area varies from one to two millimeters. The surface of the brachial-valve is abruptly deflected from three to six millimeters posterior to the margin, the angle formed measuring 90° – 105° . This sudden deflection is a highly characteristic feature of this form and makes confusion with any other Maquoketa species impossible.

The pedicle-valve is weakly convex at the beak, then turns and follows the shape of the brachial-shell, producing a cup-like cavity, which lacks the sharp angles of the brachial-valves.

Striae are distinctly alternating on the brachial-valve, from three to nine finer between two coarser ones. The coarser striae become more pronounced upon the vertical part of the brachial-valve; the finer intercalated ones tend to become obscure on this area, with the exception of one to three in each series which become coarse.

This makes the deflected anterior region of the shell quite distinctly striated and sharply contrasts it with the finely marked posterior part.

Specimens vary little in size, a typical one measuring 15 mm. along the hinge-line, 10 mm. in length, 5 mm. in depth.

Locality:—Lower Maquoketa at Clermont, Iowa. Holotype, M. C. Z. 8,540.

STROPHOMENA LAMINATA, sp. nov.

Plate 1, fig. 9, 10.

This form is smaller than the average for the genus, and less coarsely striated. It resembles no other species in this fauna so closely that confusion might result, for it possesses a characteristically laminated brachial-valve which is unique.

Shell semiovate in outline; slightly wider than long, with the

greatest convexity a little anterior of the middle. In the adult the brachial-valve is marked by lamellose growth-lines that suggest premature senility. Striations on the brachial-valve are fine, from twelve to fifteen within 5 mm. on the anterior margin. They show an unpronounced alternation of two coarser encompassing one or two finer striae. On the pedicle-valve they are finer, from seventeen to twenty in 5 mm. They show the same alternation as those of the brachial-shell.

A typical specimen measured: —

Width	Length	Greatest convexity
17 mm.	15 mm.	6 mm.

Locality: — Lower Maquoketa at Clermont, Iowa. Holotype, M. C. Z. 8,542.

STROPHOMENA sp. ind.

A small specimen 16 mm. wide along the hinge-line, 12.5 mm. long, and with a convexity of 3 mm., which equals the greatest height of the cardinal area, shows a pathological dwarfed condition. Striae are fine, five or six in 2 mm. and show no alternation. Concentric lines which tend to be prominent and lamellose are present. Concentric striae are prominent near the posterior edge of the pedicle-valve and form file-like indentations upon the radial striae. Retardation of growth is noticeable on the brachial-valve where the first concentric line is badly malformed. The pathological condition is so marked that it is difficult to identify the species and justifies a separate description.

PORAMBONITIDAE.

PARASTROPHIA DIVERGENS Hall and Clarke.

Parastrophia divergens Hall and Clarke, Pal. N. Y., 1895, 8, pt. 2, p. 222, 366, pl. 63, fig. 4-7. 48th Rept. N. Y. state mus., 1897, 2, p. 364; pl. 10, fig. 11-14. 14th Rept. N. Y. state geol., 1897, p. 364, pl. 10, fig. 11-14.

Shell of medium size; brachial-valve strongly, pedicle-valve weakly, convex. The beak is erect; and the surface slopes gently to the lateral margins. Half-way to the anterior margin the surface becomes abruptly depressed, forming broad, deep, characteristic sinus, which contains three well-defined plications. Two less-defined ribs occur on each lateral slope.

The brachial-valve is well rounded in the posterior region; the median fold becomes evident half-way to the anterior margin where it finally is well defined. The fold bears four plications; each lateral slope bears two. The type-specimens from Wilmington have from three to five plications on the median fold and three on each lateral slope. All plications, and also the fold and sinus fade away in the umbonal region, which is smooth.

Width	Length	Greatest convexity
15 mm.	12 mm.	10 mm.

In general, this representative of *Parastrophia* closely resembles the type from Wilmington, but differs in having fewer plications and a lesser convexity.

Locality: — Maquoketa (Fernvale) at Wilmington, Illinois, and Lower Maquoketa at Clermont, Iowa.

RHYNCHONELLIDAE.

RHYNCHOTREMA CAPAX (Conrad).

Atrypa capax Conrad, Journ. Acad. nat. sci. Phil., 1842, 8, p. 264, pl. 14, fig. 21.

Hall, Amer. journ. sci., 1844, 47, p. 109.

Atrypa increbescens Hall (part), Pal. N. Y., 1847, 1, p. 146, pl. 33, figs. 131, 13k-13y. Billings, Can. nat. geol., 1856, 1, p. 207, fig. 15, 16. Hall, 13th Rept. N. Y. state cab. nat. hist., 1860, p. 66, fig. 6, 7, 9-11.

Rhynchonella increbescens Hall (part) Geol. Wisc., 1862, 1, p. 123, pl. 11, fig. 2.

Rhynchonella capax Billings, Geol. Canada, 1863, p. 211, fig. 213. Safford, Geol. Tennessee, 1869, p. 275, fig. 4-6. Meek, Pal. Ohio, 1873, 1, pt. 2, p. 123, pl. 11, fig. 2. Miller, Cinc. quart. journ. sci., 1875, 2, p. 17. Roemer, Leth. Geog., 1, Leth. Pal. Atlas, 1876, p. 4, fig. 13a. White, 2d Ann. rept. Indiana bur. state geol., 1880, p. 489, pl. 1, fig. 9-11. 10th Rept. state geol. Indiana, 1881, p. 121, pl. 1, fig. 9-11. Whitfield, Geol. Wisc., 1882, 4, p. 263, pl. 12, fig. 26, 27. Chamberlin, *ibid.*, 1883, 1, p. 155, fig. 30. Keyes, Missouri, Geol. surv., 1895, 5, p. 99, pl. 41, fig. 12.

Rhynchotrema capax Winehell and Schuchert, Geol. Minn., 1893, 3, pt. 1, p. 462, pl. 34, figs. 30-34. Hall and Clarke, Pal. N. Y., 1893, 8, pt. 2, p. 183, 185, pl. 56, fig. 14-18, 20-27; pl. 83, fig. 31. Whiteaves, Pal. foss. Canada, 1895, 3, pt. 2, p. 121; 1897, 3, pt. 3, p. 178. Cumings, 32d Ann. rept. Dept. geol. nat. res. Indiana, 1908, p. 931, pl. 36, fig. 6-6h.

This well-known species is quite plentiful in several exposures of the Lower Maquoketa at Clermont, Iowa. The shell is of medium size, and varies greatly in shape with age. Some mature specimens

were more convex than their diameter in any other direction. The posterior lateral margins meet the beak sharply in young shells, but become more rounded in the adult.

The brachial-valve is always a little more convex than the pedicle and marked by a mesial ridge nearly flat and topped with four plications. This continues about two thirds the way to the beak which is strongly incurved; lateral slopes bear from four to eight simple plications.

The pedicle-valve terminates abruptly in a pointed beak which becomes strongly incurved upon that of the other shell in adults. The mesial sinus is deep and well defined in mature examples, bearing three or four sharp plications; lateral slopes each have five to seven simple striations.

The entire surface of both valves is marked by numerous very regular, strongly zigzag, and prominent lines of growth.

Rhynchotrema capax is larger than *R. increbescens* with which it is sometimes confused and has a greater convexity and thicker valves.

This species varies much in the development from the young to the adult form and has caused the name of *R. capax* to cover a multitude of faulty identifications.

Locality: — Richmond at Richmond, Indiana; Oxford, etc., Ohio; Illinois; Iowa; Tennessee; Missouri; Wisconsin; Minnesota; Anticosti; Lake Winnipeg, Manitoba; Fort Churchill, Hudson Bay, etc.

ZYGOSPIRA TANTILLA, sp. nov.

Shell small, biconvex, the pedicle-valve sharply keeled in the umbonal region, the anterior edge sharp. The brachial-valve is convex at the umbo, becomes flattened in front, with a broad shallow median sinus. The surface is covered with fine plications, the median one on the brachial-valve slightly thicker than the others. On either side of the median plane there are ten to twelve ribs.

Measurements: — The largest specimen is 5.75 mm. long and 5.50 mm. wide. A small one is 4 mm. long and 3 mm. wide.

This species is very like *Z. recurvirostris*, and differs from the other Richmondian forms in its small size. It is a less robust shell than *Z. recurvirostris*, and has fewer plications than *Z. modesta*. It is not unlike *Z. kentuckiensis*, but is smaller, less plump, and that species does not appear to show an enlarged median plication.

Locality: — Twelve specimens were collected from the Lower Maquoketa near Clermont, Iowa. Holotype, M. C. Z. 8,547.